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L. 7. No. 74. FEBRUARY, 1953. Price 1/6d. Annual Subscription: Fifteen Shillings

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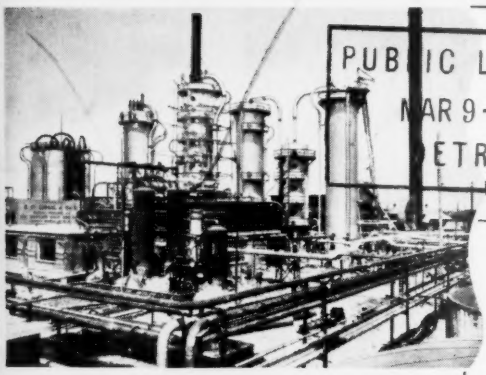

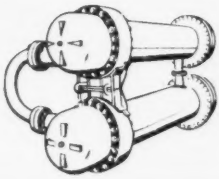

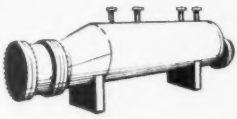

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No. 74 FEBRUARY 1953 Vol. 7

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PETROLEUM AND THE LAW

By V. BISKE*

It is intended in this paper to consider briefly some, inevitably rather disjointed, legal points which may be of particular interest to those engaged in the petroleum industry.

What is "Petroleum"?

There are several legal definitions of "petroleum", which, unfortunately, vary somewhat among themselves and hence it is important to consider the context whence those definitions are drawn.

In the Petroleum (Consolidation) Act, of 1928, "petroleum" is defined (in s.23), as follows: "'Petroleum' includes crude petroleum, oil made from petroleum, or from coal, shale, peat or other bituminous substances, and other products of petroleum". This is rather wide and in these days of a chemical industry based on petroleum, the expression "other products of petroleum" could cover almost anything.(1)

However, when interpreting a statute the words spoken by a leading judge at the beginning of the present century should be borne in mind, "...regard must be had not only to the words used, but to the history of the Act, and the reasons which led to its being passed..."(2) Hence, since the 1928 Act was passed to deal with questions involving the safety aspects of petroleum, and its products as then normally considered, it is reasonable to assume that the definition can be taken as being in fact restricted to materials which are substantially hydrocarbons.

Moreover, and this would appear to

*Based on papers read to the Northern Branch (16 Oct 1951) and London Branch (26 Nov 1952) of the Institute.

be decisive, the Act itself, by virtue of s.19, enables various other materials which are not in fact petroleum spirit, to be considered as such for certain of the purposes of the Act, mainly in connexion with conveyance of and accidents involving such materials. A fairly comprehensive Order was made in 1947[3] covering such materials as the lower alcohols, certain other inflammable organic liquids, and a whole host of inorganic compounds which could not by any possible means be obtained from petroleum but which are generally recognized to be dangerous. Consequently control over their transportation is required.

The Petroleum Act thus affords a means of exercising control over materials, chromic acid, for example, which were probably not considered by the drafters of the Act. Such control is at present restricted to notification of certain accidents, etc., since Regulations covering the road transport of these materials have not yet been issued. It may be thought that this wide power given by s.19 exhibits some of the faults of the system of delegated legislation. It has enabled control to be extended to matters which, one must presume, were not in the mind of Parliament when the Act was passed, yet there is no doubt that a useful public purpose has been served by the grant of such power. For instance, when the transport of radioactive substances became more commonplace than hitherto, owing to atomic energy developments, use was made of the Petroleum Act to regulate such transport. The Order in question has however since been revoked, as radioactive materials are now controlled by an Act of their own.

It will be noted that the Order extending certain sections of the Act to the various substances aforementioned does not cover their storage; there is therefore still the possibility that storage of ethyl alcohol made from grain is not regulated, whilst that of synthetic ethyl alcohol, the latter being a "product of petroleum", could be considered as coming within the Petroleum Act. It is however submitted that such an interpretation would be unlikely to be upheld. The fact that ethyl alcohol is specifically mentioned in the above Order and that opportunity was not taken to extend to this material the provisions of the Act dealing with storage, would be a strong indication that it was not intended that such provisions should apply to such a case.

Although it may at first sight seem anomalous that conveyance of such materials should be controllable, but not their storage, it must be remembered that the purpose of the Act was public safety. Uncontrolled conveyance of certain materials on highways obviously involves danger to the public at large; similar danger is involved in the storage of a commodity such as petroleum spirit, which modern conditions may cause any householder to have in his care. No one, however, is likely to store any quantity of more specialized materials, even highly dangerous ones such as carbon bisulphide, without a special purpose and hence without knowledge of the risk involved. Ethyl alcohol of concentrations likely to be met with in potable liquors is excluded from the extension of the Petroleum Act to this material (only applicable if the ethyl alcohol is stronger than 43° o.p.); there would be no statutory control over the conveyance in a road tanker of, say, gin.

Although petroleum is defined as above in the Act it is important to remember it is concerned only with petroleum-spirit, that is petroleum having a flash point below 73°F.

To return to the definitions of petroleum. In the Petroleum (Production) Act of 1934 this is defined as "any mineral oil or related hydrocarbon and natural gas existing in its natural

condition in strata, but does not include coal or bituminous shales or other stratified deposits from which oil can be extracted by destructive distillation".

This definition is of course only "for the purpose of this Act" and is confined to natural deposits of oil; as this was a nationalization measure before the National Coal Board was conceived, the careful exclusion of coal is understandable.

A very comprehensive definition included in the Fuel (Records and Information) Order of 1942[4] reads as follows: " 'petroleum or any product of petroleum' includes asphalt and bitumen, coke, crude and process oils, diesel oil, fuel oil, gas oil, greases, kerosene (including mineral vaporizing oil), lubricating oils, motor spirit (including aviation spirit), petroleum jelly, petroleum pitch, wax, white spirit, and other liquid petroleum products (including transformer and white oils) and includes also shale oil and the products of shale oil corresponding to the above descriptions of petroleum products". Doubtless, after this effort, the draftsman felt that he had included everything he could think of (including, oddly enough, coke, presumably intended for petroleum coke). Nevertheless a couple of years later, when the Control of Petroleum Order, 1944, was issued, he seems to have felt that something might have been overlooked; hence the above definition, which occupies seven lines of print in the original Order, was extended to eleven lines.

This mammoth definition lasted a few years but was replaced in 1948 by an amendment Order in which we had:—

" 'petroleum' means crude petroleum or shale oil, or any hydrocarbon product of crude petroleum or shale oil, excluding propane or butane, and any hydrocarbon oil made by the hydrogenation of

(a) crude petroleum or shale oil or any product derived from either of them;

(b) coal or any product derived from coal."

This is reasonably straightforward; whether it is a coincidence or not, it may be added that this Order was made at about the time that the well-known publication by Sir Ernest Gowers, entitled *Plain Words*, had been issued by H.M.S.O. It should be stressed that this definition is only mentioned out of interest to show how it developed as, with the revocation of the order containing it, it no longer has any legal validity.

A still simpler definition is given in the Oil in Navigable Waters Act of 1922, where it is stated that "The expression 'oil' means oil of any description and includes spirit produced from oil and oil mixed with water".

Apart from the definitions of the term "petroleum" which have been considered there are in various Acts and Regulations, numerous other definitions of petroleum products and groups of products. Probably the most important of these are those contained in the Customs and Excise Act of 1952. Since comment on these definitions has however been recently made elsewhere,[5] it will not be repeated here.

Interpretation of the "Abel" Flash-point Test

The flash-point limit of 73°F. has been mentioned as the boundary-line between petroleum fractions which are "petroleum-spirit", and hence come within the 1928 Act, and those which are not. It is of interest to note that the expression "flash-point" does not occur anywhere in the Act. The term used is "gives off an inflammable vapour". The apparatus to be used for determining such temperature is specified in considerable detail and the test procedure to be used is likewise laid down; it is therefore odd that, whilst details are given of how the test flame is to be applied and the rate at which the slide shall be opened and closed,

there is no definition or even mention of the actual phenomenon (i.e. "flashing") which indicates that the temperature of evolution of inflammable vapour has, in fact, been attained.

If, therefore, a case is envisaged in which a prosecution under the Act was brought, one of the points at issue being whether or not a certain material was "petroleum-spirit", it might be necessary to call expert evidence as to the interpretation of the test procedure.

S.17 of the Act, which empowers certain officers to test petroleum, does not state that such officer will certify the flash-point or even the temperature at which the material in question evolves inflammable vapour, but that he will certify whether the material is petroleum-spirit. Similarly any expert appointed by the court in cases of dispute is to report whether such certificate is correct and is not specifically required to give the actual test figure he obtains.

It thus seems that in the interpretation of the test results to a court by an expert witness, there is bound to be certain room for latitude, depending upon the expert's own interpretation of the test. As such an expert may be presumed to be acquainted with the margins of error which are liable to occur, he would presumably, in border-line cases, carry out a number of tests so as to be able to base his report on such average value as he considered to be sufficiently close to the "true" value.

Customs Regulations and Refineries

In contrast to the somewhat involved definitions for petroleum which have just been quoted, there is a very simple definition of a "refinery". According to the Customs and Excise Act, 1952, this is "any premises approved by the Commissioners for the treatment of hydrocarbon oils".

Such approval is granted on compliance with the somewhat numerous requirements of the Commissioners; these are set out in detail in Customs and Excise Notice No. 179. They call for full particulars of the premises and processes to be carried out therein, duplicate plans, lists of all vessels, pipes, etc. The refiner, if called upon, may have to provide office and sanitary accommodation for the exclusive use of Customs officers. Safety measures are laid down for tanks, to enable dipping to be accomplished without risk, and the refiner has to provide the necessary measuring instruments, and also personnel to help the Customs officer.

A very considerable amount of bookwork is called for in connexion with the duties chargeable on hydrocarbon oils; particulars are to be found in several Orders, the most important of which is probably the Hydrocarbon Oils Regulations, 1948.[6]

One customs regulation was for a long time generally ignored; the position has however been regularized since 1 January 1953, when the new Customs and Excise Act came into force. That was the prohibition on the mixing, except under licence, of light and heavy (rebated) oils. Such mixing has to be done by every user of a two-stroke engine in the country. Although this particular anomaly is now a thing of the past, the amendment to the old law contained in the new Act does not go quite far enough. It allows mixing of light and heavy oil *except* where the latter is fuel oil, kerosine, or gas oil. The prohibition on the mixing of the first two is not a serious inconvenience but the extension to include gas oil does mean that it is not possible (unless a licence is obtained) to use certain light spindle oils as upper cylinder lubricants, since such oils may have distillation characteristics which bring them within the definition of gas oil.

Storage of Petroleum Spirit

Whilst on the subject of motor vehicles, it may perhaps be of interest to say a few words about the law concerning the

storage of petroleum-spirit, i.e. oils flashing below 73°F. The regulation of such storage is one of the principal purposes of the Act of 1928 and bulk or large-scale storage is only permissible under licence. This licence is granted by the local authority concerned under such conditions as they see fit. However, to meet the requirements of individual users of motor spirit, regulations have been drawn up[7] stating the conditions under which petroleum-spirit may be kept by persons wishing to use it in motor vehicles, boats, aircraft and specified engines, such as lawn mowers, generating plants, etc. In addition, small quantities of spirit (up to a total of 3 gallons in containers not exceeding 1 pint) may be kept, without licence, for any purpose. This covers, for instance, the sale and use of small bottles of cleaning spirit, lighter fluid, and the like.

There is here however the anomalous situation, referred to earlier, caused by the storage of petroleum-spirit being strictly controlled but not that of other more dangerous materials. Thus, if a doctor were to have in his surgery a quart bottle of benzene and a winchester (i.e. $\frac{1}{2}$ gallon) of ether, no proceedings could be taken in respect of the latter but he would be committing an offence by storing the benzene, although both the quantity mentioned and the material itself present a much smaller hazard than does ether.

In the case of petroleum-spirit kept for use in engines, the exemption from a licence only applies to the user himself; hence spirit kept for sale for such purposes, or even kept by a person as a bailee, must only be kept by virtue of a licence.

The general effect of these regulations is that if a car is kept in a garage communicating with a house, then the means of separation of the house and garage are specified, i.e. a door of reasonable fire-resistance. Also the quantity of petroleum-spirit to be kept is limited to that in the fuel tank of the vehicle and in addition not more than 4 gallons kept in vessels not exceeding two in number and a size of 2 gallons. Means for extinguishing a petrol fire must be available in the store at all times when petroleum-spirit is present; a supply of sand meets this requirement.

From a strict interpretation of the regulation, even the motorist with no garage who leaves his car, regularly, in the drive alongside his house and keeps no other petrol than that which is in the tank of his vehicle, still appears liable to ensure that fire-extinguishing means are available.

Whilst such requirement would be met by the carrying of a fire extinguisher on the vehicle itself, it is not possible, in the writer's opinion, so to interpret the regulations as to make such carriage obligatory.

If, however, it is possible to store the petroleum-spirit in a place more than 20 feet from an inhabited building or highway, then whilst the quantity that may be kept without a licence is not increased above the overall maximum of 60 gallons, the limitation on the maximum size of 2 gallons for the container is withdrawn. Any such storage in larger containers must, however, be notified annually to the local authority, and precautions taken against outflow in the event of fire.

It will thus be seen that the keeping of a jerrican of petrol in a garage adjoining a house is an offence; such can could only be kept not less than 20 feet from the house (although not necessarily in a building, a hole at the bottom of the garden could be a "storage place" within the meaning of the regulations) and notice would have to be given to the local authority.

The wording of the regulations indicates that vessels (this expression appears to include the fuel tank of a motor vehicle, etc.) in which petroleum-spirit is stored must be of metal. This is unduly restrictive in view of recent

developments in plastic technology; in fact, plastic petrol tanks for aircraft are seriously under consideration, if not already in use.

Heavy Oil Vehicles

The car owner who, however, wishes to be strictly law-abiding and considers the fulfilment of all these requirements somewhat onerous is not recommended to contemplate purchasing a diesel-engined car. He would then become a person possessing a heavy oil vehicle and would become subject to the numerous requirements of the regulations[8] made by virtue of the Finance Act 1935, the Act which included heavy oils, when used in a road vehicle, in the class of non-rebatable oils. Heavy oils (all oils which are not light oils) are deemed to be used as a fuel for a vehicle if they are used as fuel for any engine with which the vehicle is equipped whether for the propulsion of the vehicle or not. Thus a portable diesel-engined generating set mounted on a lorry has to operate on fully taxed fuel. Oils used for steam-raising in steam vehicles are likewise taxable.

Dealers selling heavy oils for use in road vehicles have to keep special records, and records of a similar type have to be kept by the owner or user of a heavy oil vehicle. Moreover, he has to keep a mileage record, and is liable to be asked at any reasonable time to produce to a customs officer all documents relating to the vehicle; all entries in such documents must be made daily or not later than the day following the return of the vehicle to its base; this would be quite a nice post-holiday task for the owner of a diesel-engined car returning from a tour.

Application of the Alkali Act to Petroleum Refineries

Refineries are scheduled works within the meaning of the Alkali &c. Works Regulation Act of 1906, as extended by later enactments, the present wording of the relevant definition being "Paraffin oil works, that is to say, works in which crude shale oil is refined and works in which crude petroleum is refined and works in which any product of the refining of crude shale oil or crude petroleum is treated so as to cause the evolution of gases containing any sulphur compound". The historical sequence of the definition will be noted, the words of 1906 not being deleted but having added to them, in 1928[9] and 1935,[10] further phrases as petroleum refining developed in the U.K.

It is a requirement that the owner of a scheduled works shall use the best practicable means for preventing the escape of noxious or offensive gases. A list of the latter is given, but as this is not exclusive, other gases, not mentioned therein, could be proven, if the evidence warranted, to be "noxious and offensive". Among the gases listed, the following are of especial importance to the petroleum refining industry: sulphuric acid, SO_2, SO_3 H_2S, fumes from paraffin oil works containing any sulphur compound, volatile organic sulphur compounds.

No actual limits of tolerance for fumes from refineries are given in the Act, the maximum acid concentrations quoted therein referring to sulphuric and hydrochloric acid works. A certain amount of offensive gases is obviously regarded as inevitable, for instance in the Alkali Inspectors report for 1938 it is stated "It must be regarded as an unfortunate fact that a large petroleum works cannot be always free from odour". On looking through reports for some years past, it will be seen that the average total acidity of final escape gases from registered works has been in the region of 1 grain SO_3 per ft^3. This of course does not mean that such a value necessarily guarantees freedom from complaint, but it is indicative of what is generally tolerated.

A recent extension[11] of the list of scheduled works now includes the fol-

lowing, "Acid sludge works, that is to say, works in which acid sludge produced in the refining of coal tar, petroleum or other hydrocarbon derivatives is treated in such a manner as to cause the evolution of any noxious or offensive gas".

Whilst such extension is of importance to any separate undertaking set up specifically for the purpose of treating acid sludge, it does not, it is submitted, alter the position of petroleum refineries. The addition, in 1935 as just mentioned, of the words "any product of the refining of crude petroleum is treated so as to cause the evolution of gases containing any sulphur compounds" was sufficiently wide to include any sludge treating process, when carried out at a refinery, within the Act; hence the order of 1950 should not affect refineries, except to the extent that it may make inspectors and others more conscious of the acid sludge problem.

If, however, a refinery recovers sulphuric acid, as by hydrolysis of sludge followed by concentration or else by processing SO_2 recovered from sludge burning then, in addition to coming within the definition of a "chemical works", as mentioned below, it also becomes a "sulphuric acid works" within the meaning of the Alkali Act. In such a case by virtue of s.7 (1) (b) no objection can be taken to a discharge of acid not exceeding $1\frac{1}{2}$ grains of SO_3 per cubic foot. (It must be remembered that the tolerance of 4 grains/ft^3 mentioned in s.6 of the Act only applies to lead chamber sulphuric acid works and not to other types of such works.)

Before leaving the Alkali Act, attention may be drawn to a power which is conferred by s.15 of the Act on the owners of scheduled works. This section enables them to make special rules for the guidance of workmen in such works who are employed in connexion with any process causing the evolution of any noxious or offensive gas. Provided that such rules are approved by the Minister of Housing and Local Government there may be imposed on such workmen fines, up to a maximum of £2, for violation of such rules; such fines can be recovered in a court of summary jurisdiction.

This is a rather unusual example of conferring on a private individual the exercise of a legislative power; it does not appear as though the facilities extended by this section have been widely used.

It should also be noted that although the owner of a works is *prima facie* liable for a breach of the Act, he may, if such be the case, name any workman responsible as the actual offender and if the case against such workman is proven, any fines imposed may be recovered from him.

It must of course be realized that any rules made under the Alkali Act are in addition to, and not in derogation from, either any other applicable statutory enactment, such as the provisions concerning smoke in the Public Health Acts, and any common law rights of an individual in respect of nuisance committed.

Petroleum Refineries as "Chemical Works"

In connexion with the present sulphur shortage and the move to utilize various refinery residues, there arises a point of legal interest concerning the status of petroleum refineries.

At present most petroleum refineries are not included within the classification of a "chemical works" and hence do not come within the scope of the Chemical Works Regulations.[12] Chemical works are defined in these regulations and, included in this definition, are works where the manufacture *or recovery* of sulphuric acid is carried out. Hence a refinery making or even recovering, which has not hitherto been customary in the U.K., its own sulphuric acid, will come within the definition. The effect of this is not,

in practice, very great. The above-mentioned Chemical Works Regulations will apply, but they merely consist of safety measures, which in many cases are no more severe than those already applied in refineries (for instance in connexion with the provision of breathing apparatus).

One point in which the Chemical Works Regulations are more stringent than the Factories Act, which would otherwise be alone applicable, is in the requirement for the provision of a staffed ambulance room. By the Regulations, the latter is required in a chemical works employing more than 250 people, although under the Act, the general rule is that only first aid boxes need be provided. It will be found, however, that most if not all refineries are voluntarily adhering to the higher standard.

Another matter where the Chemical Works Regulations and the Factories Act differ is in the requirements for what, in the oil industry, is referred to as "gas-freeing" a vessel. The Factories Act requires that "all practicable steps" shall be taken to remove dangerous fumes and explosive or inflammable substances before either men are allowed to enter the vessel or welding, etc., operations may be carried out therein. The Chemical Works Regulations are however more stringent and require that, except where the persons entering the tank are wearing breathing apparatus, a certificate that the tank, etc., is safe to enter must be given in writing by a responsible person.

Works in which "the refining of crude shale oil or processes incidental thereto are carried out" come within the definition of chemical works; although petroleum refineries, unless recovering sulphuric acid, do not (nor for that matter do installations making chemicals from petroleum). Probably this is due to the Regulations having been made 30 years ago when there was no petroleum refining industry in the U.K.

It is not proposed to dwell on the position of the petro-chemical industry (incidentally, this inaccurate term which can only mean, strictly speaking, the chemistry of rocks, should be deplored; it is probably too firmly entrenched now to be removed but, to repeat a suggestion put forward some years ago, naphtho-chemical might have been a more suitable description of this field). One example, however, may be cited of how modern technical developments can lead to legal results which, it may be presumed, were unintended by those who prepared the legislation.

By the Factories Act, 1937, s.42 (1) it is laid down that washing facilities shall be available to employees. The actual words used are "...adequate and suitable facilities for washing which shall include soap and clean towels or other suitable means of cleaning and drying...". The alternative "other suitable means of cleaning or drying" should be noted. Thus a combination of a synthetic detergent and a hot-air type of hand drier would comply with the Factories Act.

However, in the Food and Drugs Act, 1938, s.13, which deals with the provisions concerning rooms where food intended for sale is prepared and stored, states that there must be provided, for the use of persons employed in such a room, "suitable washing basins and a sufficient supply of soap, clean towels...". Now the Factories Act came into operation on 1 July 1938 whilst the Food and Drugs Act came into operation on 1 October of the next year. Thus, in Acts which became effective within a short time of one another, very different wording is employed and, it is submitted, if the phrase mentioned had to be interpreted by a court, it seems that the court would have to hold that the combination of a synthetic detergent and a hot air drier could not be interpreted to mean "soap and towels"[13] and that hence such facilities would not meet the require-

ments of the Food and Drugs Act, any more than would a combination of a synthetic detergent and a towel or of soap and a hot air drier.

Where to Find the Law

Finally, a few words about where one can find out what is the law on a particular subject. It is often said that everyone is presumed to know the law. That is one of those mis-statements that have gained wide currency. The actual proposition of law is that ignorance of the law cannot be pleaded as an excuse for a breach of it (although it is interesting to note that ignorance of one's legal rights is not necessarily a bar to a civil remedy, as has been shown by one or two cases in connexion with workmen's compensation).

Most people have faced the difficulty of keeping up-to-date with scientific advances, particularly in fields other than their own. The task of keeping up with the law is perhaps even harder. After all, however revolutionary a scientific discovery may be, it is unlikely to make what has gone before completely out of date and useless. If one were to consult a twenty-year-old textbook for guidance on a scientific topic of which one was completely ignorant, except perhaps in a very few narrow fields, one would get a sound general grounding of the subject. Any newer work would probably only amplify and correct in matters of detail what one had read; admittedly the older book might leave out much now of importance, but what it did state would, in all probability, still be reasonably correct. With law it can be different. Apart from legislative action, including of course delegated legislation, a decision of the courts, which will in these days probably not be reported in the press, may completely alter the legal position for the future. Fortunately this position is well recognized and the necessary machinery exists for enabling one to keep up-to-date, although it is probably fair to say that, in the field of what may be called general abstracting, the legal profession was, till recently at least, some way behind the scientists in putting its house in order.

The importance of making sure that any work of reference consulted is up-to-date is hence evident. Actual legislation is probably the source of law that is of most importance to the industrialist. The primary source of legislation is of course Acts of Parliament, copies of which may be obtained from H.M.S.O. They are not very readable, but usually a non-lawyer will only be concerned with one or two sections of a particular Act, and as Acts of Parliament are usually well sub-divided, this makes them considerably less fearsome than they appear at first sight.

In many cases, more important than the Acts themselves, are the various regulations (S.R. & O. and S.I.) made under them. These can likewise be obtained for a few coppers from H.M.S.O. A useful advantage of obtaining publications from H.M.S.O. rather than consulting them in a library is that the Stationery Office does not normally sell revoked instruments; hence if an individual instrument is sold by them, this is a very good indication that it is still current. In addition to individual instruments there are collected volumes, both by year and by subject. The complete set of the latter (up to 31 Dec. 1948) is a massive publication costing £65 but, fortunately, excerpts dealing with individual topics can be purchased separately for a shilling or so, e.g. under the headings of Alkali Works, Hydrocarbon Oils, etc. In such cases, of course, it may be possible that a revoked instrument would be included in such a set, and it is up to the reader to verify the position. Incidentally, the subject headings have to be gone through with some care; Hydrocarbon Oils deals only with customs regulations; safety measures and production are under Petroleum,

whilst the question of Oil in Navigable Waters is under that heading. There is a certain amount of cross-referencing, but complete reliance cannot be placed upon this as many regulations are under the heading of emergency legislation. Much of this latter is what may be called sub-sub-legislation, that is, the Orders are made, not by virtue of an Act of Parliament directly, but under powers granted by Defence Regulations, themselves made under an Act of Parliament. For instance, the regulations made in 1944 dealing with safety measures to be taken in the conveyance of petroleum-spirit on canals[14] are made under Defence Regulation 76 and hence count as emergency legislation, although the regulations are very similar in type to those made in respect of road vehicles under the Petroleum Act; in the former case they are not included in the collected S.R. & O's, in the latter they are. Furthermore in the case of the revocation of a regulation, one made under an Act is usually revoked by another S.I.; in the case of one made under a Defence Regulation, this can be revoked by the revocation of the relevant Defence Regulation and hence such indirect revocation is more easy to overlook.

Reference should also be made to the very useful publication entitled "Guide to Government Orders". This lists all statutes under which powers to make orders exist, states what orders have been made or whether the power has, as yet, not been exercised. The latest edition (costing £4/4/-) covers the ground to the end of 1951, but, as in the case of the collected set, emergency legislation is not included.

A somewhat similar work entitled "Index to Statutes in Force" is also published, the subject headings are the same as in the "Guide to Government Orders" but the subject matter is Acts of Parliament and not S.R.O's and S.I's. The latest edition is up to the end of 1950 and costs £4/4/-.

Conclusion

It should be made clear that many of the interpretations which have been put upon various statutes can only be the expression of a personal opinion; there is a lack of decided cases in the field of petroleum legislation (whether that is to be taken as a tribute to the law-abiding nature of the industry or an inclination on the part of the powers that be to let sleeping dogs lie is again a question of opinion); in the absence of judicial guidance, one can only apply such rules and common-sense as are possible.

REFERENCES

(1) For a fuller discussion of this point, see Burgess, S. G., *J. Inst. Petrol.*, 1947, **33**, 363.

(2) Lindley, Sir N., M.R., in *Thompson* v. *Lord Clanmorris* (1900), 1 Ch. 725.

(3) The Petroleum (Inflammable Liquids and other Dangerous Substances) Order, 1947 (S.R. & O. 1947, No. 1443).

(4) S.R. & O. 1942, No. 1388.

(5) Biske, V., *Petrol. Times*, 1952, **56**, 262.

(6) S.I. 1948, No. 2132.

(7) The Petroleum-Spirit (Motor Vehicles &c.) Regulations, 1929. S.R. & O. 1929, No. 952.

(8) The Heavy Oils (Road Fuel) Regulations 1935. S.R. & O. 1935, No. 717 (as amended by 1945, No. 1648; 1946, No. 1937; 1948, No. 2132).

(9) The Alkali &c. Works Order, 1928. S.R. & O. 1928, No. 26.

(10) The Alkali &c. Works Order, 1935. S.R. & O. 1935, No. 162.

(11) The Alkali &c. Works Order, 1950. S.I. 1950, No. 364.

(12) S.R. & O. 1922, No. 731.

(13) "Where two statutes dealing with the same subject-matter use different language, it is generally a fair presumption that the alteration in the language used in the subsequent statute was intentional" per Brett, J., in *Dickenson* v. *Fletcher* (1873), L.R.9 C.P.1 at p. 8.

(14) The Petroleum Spirit (Canals) Order, 1944. S.R. & O. 1944, No. 641.

WORLD PRODUCTION INCREASES

World production of crude petroleum in 1952 was 5.3 per cent, or about 31 million metric tons, greater than in 1951 according to figures recently issued by Petroleum Press Service. From the details in the accompanying table it will be seen that in the post-war period (1946-52) production has trebled in the Middle East, increased by two-thirds in the Caribbean area, and by one-third in the U.S.A. The largest volumetric increase was in the U.S.A.—76 million tons—and this was closely followed by the Middle East with nearly 71 million tons. Excluding Persia, Middle East annual production has increased by 90 million tons.

ESTIMATED CRUDE OIL PRODUCTION

	1946	1951	1952
	Thousand metric tons		
North America:			
U.S.A.	234,215	302,600	310,000
Canada	978	6,444	8,000
Caribbean Area:			
Venezuela	56,700	89,062	95,000
Colombia	3,189	5,387	5,500
Trinidad	2,900	3,024	3,000
Other Latin America:			
Mexico	7,040	10,934	11,000
Argentina	2,976	3,583	3,600
Peru	1,663	2,136	2,200
Ecuador	306	359	370
Chile	—	97	100
Others*	68	170	170
Middle East:			
Saudi Arabia	8,200	37,200	41,500
Kuwait	800	28,226	37,500
Iraq	4,607	8,630	19,000
Qatar	—	2,364	3,200
Egypt	1,282	2,333	2,400
Bahrein	1,100	1,509	1,500
Persia	19,479	16,838	1,000
Turkey	—	19	20
Far East:			
Indonesia	300	7,445	8,500
British Borneo	300	5,000	5,000
Japan	190	340	340
India	300	250	250
W. New Guinea	—	250	250
Pakistan	—	152	150
Burma	2	80	110
European Area:			
Germany	650	1,366	1,750
Netherlands	63	714	700
France	52	293	350
Yugoslavia	21	156	150
Morocco, Algeria	3	82	150
U.K.	57	18	45
Italy	10	45	45
FREE WORLD TOTAL	**347,451**	**537,106**	**562,850**
Eastern Europe and China:			
U.S.S.R.	21,600	42,400	47,000
Rumania†	4,190	4,200	4,100
Austria	845	2,300	3,000
Hungary	685	500	500
Poland	117	200	230
Albania	100	170	200
Czechoslovakia	29	75	110
China	60	100	150
WORLD TOTAL	**375,077**	**587,051**	**618,140**

*Bolivia, Brazil, Cuba.
†Estimated. Official statements claim a higher level.

Evidence of the relationship between petroleum production and general industrial development is provided by the U.N. production indexes, excluding the U.S.S.R. These show that the index for crude oil production rose from 81 in 1946 to 127 in the second quarter of 1952. Industrial production rose from 82 to 125 in the same period.

The U.S.A. achieved a new production record in 1952, although her share of world total was only 51 per cent compared with over 60 per cent both before and immediately after the last war.

Western Canada is now eighth in the list of oil producers. Venezuela was chiefly responsible for increases in the Caribbean area and there was little change in output from other Latin American countries.

In the Middle East a production rate of over 110 million tons per year was reached towards the end of 1952. With the exception of Egypt and Bahrein, all countries outside Persia contributed to this increase.

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COMPANY PRODUCTION—CRUDE OIL

	Nov. 1952
	tons
Iraq Petroleum Co. Ltd. (Kirkuk field)	1,555,803
Basrah Petroleum Co. Ltd. (Zubair field)	239,516
Mosul Petroleum Co. Ltd. (Ain Zalah)	84,710
Petroleum Development (Qatar) Ltd. (Qatar, Persian Gulf)	305,482
Kuwait Oil Co. Ltd.	3,229,942
	Dec. 1952
	barrels
Kern Oil Co. Ltd.:	
California	108,886
Trinidad	76,959
Trinidad Petroleum Development Co. Ltd.	294,893

AROUND THE BRANCHES

London Branch

On 18 December the Branch held their annual film show. The Chairman, A. W. Deller, introduced the programme which consisted of:—

Highlights of Farnborough 1952—a film of the S.B.A.C. Show. Only the military sequences of the film were shown.

Rig 20—The story of the fire that broke out when drilling in the oil well No. 20 at Naft Safid, and the five-week battle to control it.

Refinery in Miniature—The construction of a detailed model of the Fawley Refinery, with interesting comparison shots between reality and model.

Oil for the 20th Century—The story of the history and growth of the A.I.O. Co. from 1901 to 1951. Much of the film was made 40 and even 50 years ago.

Detergents—The story of laundering through the years and in many countries, introducing detergents made from petroleum.

The meeting was very well attended, and once again the popularity of petroleum films was most apparent.

After the show quite a number of the members of the Branch visited "The Bolivar" where seasonal toasts and good wishes provided the excuse, although none was needed, for the exchanges of hospitality.

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High Efficiency—A Handbook for Motor Cyclists—Recently published by Vacuum Oil Co. Ltd. is a new edition of this 80-page handbook of interest to all motor cyclists. Apart from information on the engine and its lubrication and on how to deal with minor troubles, there are articles of general interest on touring, on trials and scrambles, and on tuning. The booklet is illustrated with pictures and diagrams and copies are obtainable from any office of the Company.

OIL COMPANY ORDERS IN THE U.K.

The Oil Companies Materials Secretariat has issued the following statement of the value of orders placed in the United Kingdom by oil companies during July to September, 1952.

Geophysical and other exploratory equipment, etc.	8,500
Specialized equipment for oil drilling and production, including oil casing, tubing, etc.	3,732,200
Specialized equipment for oil refineries, etc. (not including pumps and valves)	505,500
Drum and can-making, filling and cleaning equipment, kerbside pumps and other oil metering and dispensing equipment, etc.	298,800
Railcars, road tankers, aircraft refuellers, etc.	176,800
Drums, drumsheets and tinplate	3,189,200
Tankage (including tank fittings)	1,294,200
Tubulars, pipe fittings and valves (ferrous and non-ferrous)	5,395,600
Pumps (excluding slush, oilwell, and kerbside)	344,700
Boilers, boiler house plant and accessories, etc.	128,500
Electrical equipment—motors, generators, transformers, etc.	1,397,100
Instruments, meters and gauges, etc.	280,200
Prime movers and compressors	306,100
Machine and hand tools, welding and miscellaneous machinery and stores	1,443,800
Ferrous and non-ferrous plates, sections, sheets, and bars	924,400
Automotive equipment, all types	1,008,600
Laboratory equipment and chemicals, including hospital and medical supplies	121,600
Bulk chemicals, catalysts, barytes, etc.	2,626,700
Cement and other building materials and hardware, including timber	904,000
Commissary, general requisites for office, warehouse, household, club, sports, etc.	904,700
	£24,991,200

PERSONAL NOTES

Dr Thomas Baron, Shell Development Co., Emeryville, has been awarded the American Institute of Chemical Engineers 1952 Junior Award in chemical engineering, in association with **Lloyd G. Alexander** of Oak Ridge National Laboratory. Their paper was entitled "Momentum, mass, and heat transfer in free jets".

C. A. P. Southwell, M.C., past-president of the Institute, has been elected president of the Oil Industries Club for 1953.

B. R. Fraser, B.Sc., recently appointed assistant refinery manager of Vacuum Oil Co's new refinery at Coryton, Essex, joined the Burmah Oil Co. in 1927 as plant chemist at their Digboi, Upper Assam, refinery, and subsequently became refinery manager.

W. T. Nichols, director, General Engineering Department, Monsanto Chemical Company, has been elected President of the American Institute of Chemical Engineers for 1953.

Other elections are **C. G. Kirkbride,** president and director of Houdry Process Corporation, as Vice-President; **E. V. Murphree,** president, Standard Oil Development Co.; **G. G. Oberfell,** previously with Phillips Petroleum Co. and now Consultant; and **W. T. Dixon,** manager, Design Division, Atlantic Refining Co., as directors.

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STPTC—The present address of the Standardization of Tar Products Tests Committee is Oxford Road, Gomersal, nr. Leeds, to which all communications and orders for publications should be sent. The Hon. Secretary of the Committee is now P. V. Watkins.

NEW YEAR HONOURS

C. A. P. Southwell, M.C., managing director of Kuwait Oil Co. Ltd. and a past-president of the Institute of Petroleum, was appointed a Commander of the Civil Division of the Most Excellent Order of the British Empire (C.B.E.) in the honours awarded by Her Majesty the Queen at the New Year.

Other honours include:—

Baron—**Sir Clive Baillieu,** K.B.E., C.M.G., director, Trinidad Leaseholds Ltd.

K.B.E.—**Colonel Harold Charles Smith,** C.B.E., president, National Benzole Association, and director, National Benzole Co. Ltd.

Knighthood—**H. Roxbee Cox,** chief scientist, Ministry of Fuel and Power.

C.B.—**W. H. Glanville,** director, Road Research Laboratory, D.S.I.R.

O.B.E.—**J. W. Drinkwater,** assistant director of Engine Research, Ministry of Supply.

Captain J. C. Leybourne, lately Master, s.s. *British Talent*, British Tanker Co. Ltd.

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G. O. Higgins, F.Inst.Pet., who negotiated on behalf of "Shell" Overseas Exploration Co., the new concession in Qatar referred to on page 64, came out of retirement for this special job. He was responsible for directing rehabilitation of the Seria, Borneo, oilfields.

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It is with regret that we record the death of **Dr V. N. Ipatieff** who, since 1930, has been associated with the Universal Oil Products Co. Dr Ipatieff, who was 85 years of age, was well-known for his researches in the field of hydrocarbon chemistry.

PETROLEUM COMMITTEE OF I.L.O.

A long-term policy for "social services in the petroleum industry", worked out and adopted in October by the Petroleum Industrial Committee of the International Labour Organization, is generally considered to be one of the Committee's best achievements.

The Petroleum Committee was meeting for its Fourth Session at Scheveningen, in Holland. Like other I.L.O. industrial committees, it comprises Government, employer, and worker delegations from countries in which the industry plays a major part. It aims at the gradual improvement of industrial relations and industrial conditions, achieved through the exchange of information and ideas among people who have personal knowledge of the industry's work and problems.

The question of "social services" had been debated at the Committee's previous session, at Geneva in 1950. Problems considered at that session referred to housing, medical services, and education. The work of the recent meeting covered supply schemes for workers and their families, co-operative societies, canteens and meals, hygienic amenities, and transport facilities. It dealt also with the cultural and recreational opportunities which are necessary for the morale and general well-being of the industry's workers. Conclusions are embodied in a memorandum which includes important passages on the administration and future development of social services.

As at previous sessions, major difficulties in the committee's work arose from the wide range of social and economic conditions in the various areas in which the industry operates. Because of the differences between industrially developed countries and those which are in early stages of their industrial history it was virtually impossible to make a blue-print for social services which would be applicable in all centres. Making recognition of this point in its memorandum, the Committee devoted the greater part of its work to conditions in the under-developed territories. It was agreed that until these

The British Delegation. Seated (left to right): *H. R. Nicholas, J. G. Stewart, Miss D. Slade, J. B. Kay. Standing: M. A. C. MacNeill, Brig. S. H. Longrigg, M. W. Guinness, T. Eccles, J. Bowen, R. B. Southall, B. W. R. Mooring, T. T. Scott.*

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areas reached a fuller stage of social and industrial development, petroleum companies operating in them should make available for their employees services which would normally be provided by private commercial enterprise or by the state. As general conditions in these countries improved the services which, for the present, would be provided by the companies would gradually be integrated into the social and industrial life of the general community.

In addition to its work on social services, the Committee studied and discussed the principles and methods used in determining wages in the industry. Here again the wide diversity of conditions and customs in the many different areas made it impracticable to achieve any real degree of standardization. But it was significant that practically all of the delegates—whether from Governments, employers or workers—were strongly in favour of responsible and effective collective bargaining as the best means of regulating wages. Where effective collective bargaining did not exist, other wage-fixing machinery appropriate to the country in question should establish minimum wage-rates which would ensure "a decent and dignified standard of living for the workers". There should be no obstacles to the development of free trades unions.

The Committee also surveyed and debated recent developments in the industry. Further resolutions adopted concerned contract labour, industrial relations, and hours of work.

The U.K. Government Delegation was led by J. G. Stewart, C.B.E., of the Ministry of Labour and National Service. He was accompanied by John H. Brook, C.M.G., and J. B. Kay of the Ministry of Fuel and Power. The Employers' Delegates were R. B. Southall, director and general manager of National Oil Refineries Ltd. and M. W. Guinness, head of the Industrial Relations Department of Shell Petroleum Co. Ltd. They were assisted by T. T. Scott, Labour Adviser to Shell Petroleum Co. Ltd., M. A. C. MacNeill, head of the Industrial Relations Division of the Anglo-Iranian Oil Co. Ltd. and B. W. R. Mooring of the same Division, L. W. Berry, a director of Lobitos Oilfields Ltd., Brigadier S. H. Longrigg, O.B.E., of The Shell Petroleum Co. Ltd., and John Bowen, Employee Relations Manager of the Esso Petroleum Co's Fawley refinery.

The United Kingdom Workers' Delegates were H. R. Nicholas, National Secretary of the Metal, Engineering and Chemical Group of the Transport and General Workers Union, and T. Eccles, a member of the T.U.C. General Council and of the General Council of the National Union of General and Municipal Workers. Mr Nicholas was elected Chairman of the Workers' Group, comprising Workers' Delegates from all the countries represented, and to his able and co-operative handling of this office is owed in no small measure the success of the Committee's work.

The Chairman of the Session was Dr Victor Montoya, of Venezuela.

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"Careers for Geologists and Geophysicists"—An interesting 28-page booklet under this title has been issued by the Shell Petroleum Co. Ltd. and contains much useful information to those seeking employment in this sphere of the Royal Dutch/Shell Group's activities.

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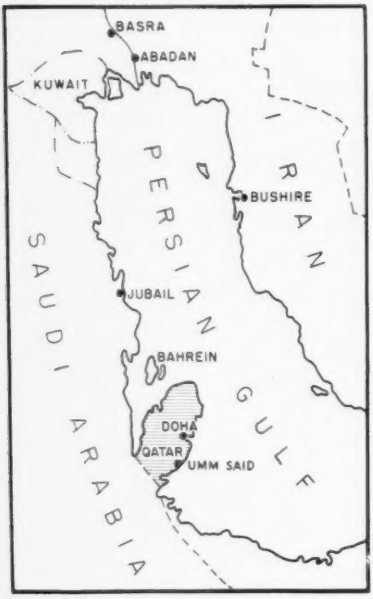
VACUUM'S NEW TANKER

On 18 December, the Vacuum Oil Company's new 1,640-tons d.w. tanker *Vacuum Pioneer* was launched by Mrs Middleton, wife of J. Blake Middleton, a director of the Company.

The vessel will be used for carriage of lubricating oils from Coryton to the compounding and blending plant at Birkenhead, and is fitted with five divided tanks giving ten separate cargo compartments.

NEW QATAR CONCESSION

"Shell" Overseas Exploration Co. Ltd. has recently been granted a concession by the Sheikh of Qatar covering an area extending into the Persian Gulf outside territorial waters. It is planned to immediately start exploration operations and the terms of the concession provide that if oil is eventually discovered in commercial quantities, a 50-50 arrangement would apply.



The independent Sheikhdom of Qatar has an area of 8,000 square miles and its main occupations outside oil operations are pearling, fishing, and grazing. The land and territorial waters of Qatar are held under concession by Petroleum Development (Qatar) Ltd., an associate of the Iraq Petroleum Co., and oil has been produced for several years and shipped from the port of Umm Said.

ACHIEVEMENTS OF THE OIL INDUSTRY

In a recent speech to the Fuel Luncheon Club, F. A. C. Guepin, a managing director of the Shell Group, said that the oil industry's achievements are a function of free enterprise.

Since 1938, world oil production has increased at a rate that is four times as great as the increase in European, and 15 per cent greater than that in U.S., industrial activity. Oil exploration, particularly, is highly competitive. Despite every care, in the United States alone, over 17,000 dry holes were drilled in 1951 representing 39 per cent of the total new holes drilled in search of production. In Canada, one major oil company drilled 130 dry holes over a span of 28 years before discovering their first major oilfield. In Ecuador, which held great promise, Shell and a U.S. partner spent £9 million before abandoning the search for oil and writing off the expenditure as a loss. All this shows the heavy capital investment and considerable element of risk involved.

By the end of 1953 refining capacity in Western Europe is planned to be over 90 million tons per annum, nearly a five-fold increase since pre-war. Of this, over 30 million tons will be in the United Kingdom, representing nearly a 15-fold increase. Keen and continuous competition has also stimulated the rapid development of refining techniques.

The cost of supplying oil products to the world is very great. By the end of 1952, the oil industry in the U.S.A. will have invested, since the war, about $17,000 million; outside the U.S.A., during the same period, it will have invested well in excess of £2,000 million. The industry is spending £50 million per annum on research alone. Since the world's capital markets do not produce money on this scale, a large part has to be financed out of the industry's profits.

Oil industry profits are low per gallon sold. Their size is a direct function of the bigness of the business. The Shell Group earns less than one penny per gallon net profit on its business; in 1951 it paid more than four times its total net profits in various taxes and levies. It has invested more than £100 million on capital projects every year since the war.

The ultimate of bigness is not state-owned enterprise. The two have nothing in common. The international team work of the oil industry can only prosper under free enterprise. Although free enterprise must conform to the discipline, general welfare, and moral code of the community, it is the economic expression of a social system that values, respects, and requires individual freedom.

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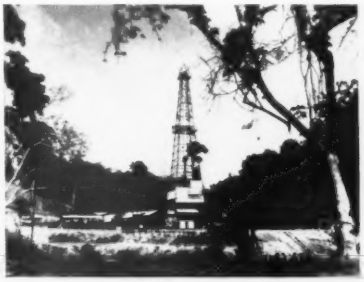
PAKISTAN OIL FIND

The first well to be drilled at Chak Naurang, near Chakwal, Punjab, by Pakistan Petroleum Ltd., has encountered oil at a depth of 7,700 feet in limestone. After acid treatment the well flowed at the rate of about 200 barrels per day. The crude oil contains a high proportion of asphalt.

The Company is also drilling a second well at Patharia and their deep test at Patiya is now at over 7,000 feet. In the Sylhet district geophysical work is in progress.

New Well at Sui

On 19 December, His Excellency Mian Aminuddin, the Acting Governor of Sind, performed the spudding-in ceremony of a new test well at Sui, which is located about five miles from the first well and which is intended to explore the extension of the limestone in which gas was found in that well. Welcoming the Governor and other officials, M. J. Condon (chairman of the Company) said that considerable work had been done since the company first started operations in July 1950 and it was largely due to the co-operation and assistance of their Pakistani staff and workmen. In particular, he wished to thank the Tumandar of the Bugti Tribe, Sirdar Akbar Khan, for his sympathetic co-operation, for which they were most grateful.



The test well at Patiya in Chittagong hill tracts.

If the new well confirmed that the limestone containing the gas was of uniform thickness and porosity, it would also confirm the existence of an appreciable gas reservoir, which could not fail to be of international importance. During the drilling of the well, careful tests would be made to ensure that no possible sources of oil were overlooked, and he referred also to the two major test wells which the company were drilling in East Pakistan, and to the deep test at Chak Naurang.

Natural Gas in Pakistan

A natural gas zone has been discovered at Sui, Dera Bugti, in Baluchistan in the first well drilled there by Pakistan Petroleum Ltd. Drilling started on the first test well at Sui in October 1951, a depth of 10,049 ft being reached in July, 1952. No oil was found.

INSPECTION OF REFINERY EQUIPMENT*

By E. J. M. TAIT† (Member)

Introduction

Refinery equipment, unlike field equipment, is subject to the effects of high temperature as well as pressure, and, as is well known, exposure to high temperatures for long periods, which is necessary in the modern refinery, results in deterioration of equipment. Corrosion also is more active in high temperature conditions as a general rule, and for both of these reasons, frequent inspection is necessary.

In the last ten years, great progress has been made in the manufacture of corrosion- and heat-resisting alloy equipment which gives greatly increased service life compared with carbon steel; however, even alloy steels do not provide protection against all conditions, and while longer periods between inspections are permissible when alloy steel equipment is used, the regular inspections are still very necessary.

In most refineries, each operating unit is given an annual inspection with a six-monthly check-over of any particular item or items of equipment which may be subject to heavy corrosion; providing no change is made in operation or charging stock, a definite corrosion rate for each unit can be calculated. Corrosion rates are usually calculated in decimal points of an inch per thousand hours on stream, or in European countries, in millimetres per thousand stream hours.

From the corrosion rate, the expected service life can be arrived at and from this figure can be determined the amount of spares to be carried in stock. No refinery can afford to invest large sums of money in spare equipment unless it is likely to be put into service in the near future. Efficient inspection played an important part during the last war by ensuring that maximum life was obtained from equipment, which in many cases, would have been scrapped years before, and at the present time, when the supply position is, if anything, worse than during hostilities, it is equally important, both from an economic and safety standpoint, that the high standard of efficiency attained during the war years should be continued.

*Trinidad Leaseholds Ltd.

†From a paper read to the Trinidad Branch of the Institute of Petroleum.

Inspection, Organization, and Equipment

In any refinery the size of the inspection department does not depend so much on its capacity, as on the number of processes involved, e.g., a 20,000-barrel refinery consisting of only a crude distillation unit with treating facilities obviously does not need as much inspection as one of the same capacity but with thermal cracking and reforming units.

The high-pressure units, because of the high temperature and pressure used, demand much more frequent inspection to ensure that the process equipment is maintained in first-class condition, and while in the first instance inspection could probably be carried out by one full-time inspector with a part-time assistant, at least three men would be required to carry out the work in the second instance.

An inspection department should cover all equipment in the refinery during the course of the year including storage tanks, which should be given an annual exterior check-up; full internal examination of storage tanks, of course, can only be carried out when they are emptied for cleaning which will probably be once in five years.

Another important point is that the information obtained at inspections should be properly recorded and issued in report form as soon as possible afterwards; the condition of the equipment should also be recorded on cards which can be kept in the files for easy reference. At least one competent clerk is therefore necessary to keep the information up to date and to look after the files. An inspection department without accurate records is like a ship without charts.

Staff and Duties

In the average refinery of say 50,000 to 70,000 barrels per day, a minimum of six inspectors are required with the chief inspector who should be a qualified mechanical engineer with wide experience in the operation and maintenance of refinery equipment. The chief inspector is responsible for keeping the management fully informed of the condition of the operating equipment; he should also advise on the type of equipment to be installed in the case of any plant modification or revamp, and should have available the latest information on the most suitable alloys for any particular service. He should co-operate as closely as possible with the refinery superintendent and refinery engineer in the organization of inspection and must ensure that while the work carried out is as complete as possible, it does not delay the maintenance department in getting the unit ready for starting up. A good chief inspector obtains all the information he requires without keeping a plant off stream longer than is absolutely necessary.

The assistant inspectors can be organized either to cover each unit or group of units, or they can be given charge of one particular item of equipment; for example, one man can be placed in charge of all furnace inspection, another of pressure vessels, and a third of heat exchangers and condenser equipment, and so on. Both methods are widely used and have their advantages, but the latter scheme has the advantage that junior men can be gradually worked up the grade and given more important equipment to inspect as they gain experience. It is a good plan to include, if possible, a licensed boiler inspector who will ensure that all boilers and air vessels are maintained in accordance with Government regulations, and although he may not be able to certify his company's own boilers, he will ensure that all records are kept up to date.

Records

Since accurate records are of such importance, reports should be full, but concise and should present as clear a picture of the condition of the unit as possible. For this reason sketches or isometric diagrams are preferable to lists of figures, as they are much easier to follow and if negatives are prepared beforehand the necessary prints can easily be run off. This policy is followed in many refineries where the inspectors carry a pad with them when making the inspection and note down the exact location measured together with the thickness found. Isometric diagrams of process piping and heaters are generally shown as an elevation indicating the position of each tube and return bend; pressure vessels are usually shown with the shell opened out flat as a rectangle.

Tools and Equipment

During the last few years great progress has been made in the development of electrical measuring instruments, and foremost among these is the audigage, which is a resonance-type instrument, battery operated, with a conversion table which indicates the thickness corresponding to the measured frequency difference. This instrument is most useful for spot checking, particularly on thick-walled vessels; pitting is difficult to detect and measurements

less than $\frac{3}{16}$-inch are not possible. Fluorescent penetrant inspection (Zyglo) is also becoming popular for locating defects open to the surface, but is not yet widely known. The great advantage of the audigage is that it avoids the necessity for breaking out equipment to obtain wall thickness. Apart from the above-mentioned measuring devices, the tools required for inspection are relatively simple and inexpensive.

First and foremost among the necessary tools are several calipers and a 2-lb. hammer. The short-tube caliper used for measuring the inside diameter of furnace tubes is arranged to indicate the internal diameter of the tube on a scale twice the actual size. It is generally marked in 1/64ths of an inch or, in countries where the decimal system is used, in millimetres and centimetres. As this caliper can be used only for measuring the ends of the tubes, a special long caliper is required to measure the tubes throughout their entire length; there are various types of long caliper in use throughout the world, some electrically operated; however, the manually operated type is very useful, easy to read, and not too cumbersome to handle.

The pistol-type caliper is also very popular, light in weight, and easy to read; however, the "U" type of caliper although heavier to carry, is extremely simple, has no spring or working parts to go wrong, and can be made up in any workshop. A light portable electric drill and thickness gauge are essential for obtaining accurate measurements of wall thickness; caliper readings, at best, can only be regarded as an indication. There is only one way to measure wall thickness accurately and that is by test hole measurement.

A depth gauge for checking the depth of pitting, a good electric torch, and magnifying glass, complete the inspector's essential kit.

A test room is very necessary in an up-to-date inspection department. Equipment should be provided for carrying out tensile, compression, hardness, and transverse bend tests. It is also worth while having a tensometer for testing smaller test pieces, as on some occasions the fittings which it is desired to examine may not be large enough to furnish a standard-sized test specimen.

A good sturdy work-bench should be provided with a vice and emery wheel for cleaning up samples for test. The test room is also a good place in which to house the museum which should contain any item of equipment which has been removed from service because of excessive corrosion, erosion, or faulty workmanship.

Inspection

The object of inspection is to find the condition of the operating equipment and having found that, to recommend the repairs or replacements (if any) which will be required to enable the unit to be maintained in service under similar operating conditions as previously.

For the purpose of this paper, it is proposed to deal with the inspection of a Dubbs cracking unit which operates under fairly high temperatures and pressures, and must therefore be thoroughly inspected at regular intervals.

In such a unit each piece of equipment has a calculated minimum thickness which depends upon such factors as the material from which it is manufactured and the operating temperatures and pressures it has to withstand; this is known as the retiring thickness because when this thickness is reached, the fitting is either retired from service or repaired.

The principal sections of the plant where corrosion most frequently occurs, are the heaters and the pressure vessels, piping and fittings, and heat exchangers.

Furnaces

The most important part of any furnace or tubular heater is the coil consisting of tubes connected together by headers or return bends which are so constructed that they can be opened up for removal of coke at shutdowns. In the distillation heater flange bends are satisfactory as long periods generally elapse in these units between shutdowns for clean out of the equipment.

Engineers the world over differ in their ideas on the design of heater tubes for high temperature service; some base their designs on short-time tensile strength at the required temperature and others, believed to be in the majority, on creep strength with a creep rate of 1 per cent in 10,000 hours or 1 per cent in 100,000 hours. Considerable support has lately been given to the idea of using the rupture strength and a stress producing rupture in 100,000 hours when designing tubes for cracking service. This rupture test appears to be more suitable when designing cracking heater tubes mainly because it considers rates of deformation closer to those encountered in cracking service, particularly during the overheating period which usually precedes failure.

Retirement dimensions are calculated on the same basis as the design and tubes which are designed on creep strength are therefore retired on creep strength; however, a greater creep rate is often used for retirement purposes, thus, when a creep rate of 1 per cent in 10,000 hours is used for design purposes, a rate of 1 per cent in 3000 hours is often used for determination of retirement thickness.

Inspection of Tubes and Headers

After the short caliper has been used to check the internal diameter of the heater tubes at the end where they are expanded into the return fittings and immediately behind, the long caliper is used to measure the internal diameter of the tubes along their entire length by inserting the caliper from each end. Tube calipering is monotonous work, particularly when tubes are not very clean and loose coke makes accurate measurement difficult. Lately, since tubes are mostly cleaned by burning out with steam and air, calipering is a much quicker job and readings are much more accurate.

The outside diameter of the tubes in the radiant section of the heater should be checked at this time either by micrometer or ring gauge. As the maximum retiring outside diameter is known, a ring gauge made to this dimension is generally used as this provides a quick method of judging the condition of the tube. The ring gauge is usually made from $\frac{1}{4}$-inch or $\frac{5}{16}$-inch plate and is made semi-circular so as to cover half of the tube at a time; it is usually between 2.5 to 5 per cent oversize according to the material from which the tube is fabricated. In other words, internal diameter of the ring gauge equals the retiring diameter of the tube. When all tubes have been calipered the inspector then makes his recommendations for replacement at the same time proceeding with the measurement of the return fittings and headers. The time taken to do this will depend on the type of fitting used. The plug type of fitting can be examined fairly quickly, but if the measurement of headers of the type which have separate removable return bends is a much longer job because in addition to calipering the tube end fittings, the inspector has to measure the "U" bends to find the minimum thickness, which is generally found to be on the outside of the bend midway between the centre of the fitting and the end which fits into the tube end fittings.

Where the headers are of the old box type, the thinnest point is usually found on the bottom, sometimes in front of the tube end and often in the centre of the fitting between the two tube ends;

provided the corrosion is in the form of pitting this can be repaired by electric welding, but if the fitting is corroded down to the retiring thickness it must be removed from service. In some cases, it will be found that burning out with steam and air causes increased corrosion and or erosion, particularly in the "U" bend type of header where it appears to be concentrated in the annular space round the tube end; this causes the coke which is not removed by mechanical cleaning to be completely burnt away by the burning and no longer affords protection to the fittings; in this case a mixture of lumnite cement and fine aggregate has been found to give excellent results on this area of the header.

Apart from corrosion there are other conditions which may necessitate removal of headers; stretching of the plug seat often occurs and this will result in the head of the retaining screw seating hard against the lug without holding the plug firmly in position; if oversize plugs are available they will solve the difficulty, otherwise the header will have to be scrapped.

Cracks are frequently found in "U" bend headers usually at the point where the ears join the main fitting, these are generally caused by the application of too much pressure when tightening up the "U" bend; no more than two men should be required to make these fittings tight. These cracks in most cases are superficial and not serious, but should they be deep enough to show any sign of a leak under test the header should be taken out of service. In most cases cracks can be chipped out and welded and the header later returned to service. On the other hand, taking the header out of service means the sacrifice of tubes, which should be avoided wherever possible. It is possible that some tubes will be recommended for replacement and while these are being cut out the inspector can further examine the header fittings from which tubes recommended for replacement have been removed. He will be able to examine these fittings closely and should pay particular attention to the neck and that part of the header into which the tube is expanded; he should check the depth of each serration and make sure that it is not less than 0.125 inches; if less, the serration or groove will have to be machined out, otherwise a good sheer point will not be obtained when the new tube is installed. Care should be taken when cutting out the old tube ends from the header that the fittings are not damaged through faulty manipulation of the torch.

Provided the depth of the groove is satisfactory and the header otherwise in good condition it may be returned to service and the inspector should check the internal diameter of the neck both in the groove and the neck proper with a micrometer gauge, making sure that all loose coke and scale have been cleaned off; he should then check the outside diameter of the tube to be installed having first made sure that both ends have been cleaned and all roughness removed with the file. He will then agree with the maintenance engineer the amount of expanding the tube requires.

When the tube has been expanded, check measurements must be taken to see that it has been expanded to the correct amount and also to obtain the original measurement from which the future corrosion rate will be calculated.

Having completed the inspection of tubes and headers, the inspector should then carry out visual external and internal inspection of the heater to make sure that firebrick is not broken or out of place and that the flue gas and air ducts are not in need of repair; dampers should be inspected to see whether they are warped or burnt, and opened and closed several times to make sure they are in working order. It will often be found that small pieces of insulation become jammed

between the damper and frame making it impossible to move; the damper remote controls should also be tried out at the same time as it often happens that the wire has broken or slipped.

All emergency steam lines to the tube and header compartments and all valves whether hand or remote controlled should be tried out to see that they are not jammed or plugged and that steam is available for quenching a fire anywhere in the tube and header compartments.

Vessels

Practically all refinery vessels are now of fusion welded type, designed and constructed in accordance with the API-ASME Code for Unfired Pressure Vessels; this code allows a safety factor of 4 to 1, the tensile strength of the material from which the vessel is fabricated being taken as 25 per cent of the actual figure at atmospheric temperature, when calculating the allowable working pressure.

The many types of vessel used in the petroleum refinery can for inspection purposes be divided into two types; namely, vessels with internal equipment, such as fractionators, strippers, etc., and vessels with no internal equipment, such as reaction chambers, receivers, etc. When complete inspection is to be carried out on any vessel it is necessary for all removable internal equipment such as trays, etc., to be taken out; permanent fittings such as tray supporting angles, etc., which are welded to the shell can be left provided they can be fully examined by the inspector. The vessel should then be thoroughly cleaned and, if possible, sandblasted over the entire surface; small hair-line cracks which are not normally detectable can easily be noticed after sandblasting as the crack will show up black against the grey sandblasted surface. Cracks generally occur in welded seams or nozzle joints and they should be examined very closely, particularly if the nozzle is subject to heavy stresses during operation by reason of its attached piping.

Today it is not usual for cracks to occur in welded vessels, particularly in "A" class vessels which are stress-relieved and X-rayed during fabrication, but should a crack be discovered it must be chipped out until every sign of it has disappeared and the groove then built up with welding rod. If a large amount of repair work has to be carried out to welded seams or nozzles involving much welding it may be necessary to stress relieve the vessel on site. This can be done by covering all protected parts of the vessel by insulation from the outside and installing a gas burner in the bottom manhole. The temperature should then be raised at a rate of about 60° per hour to 1100°F and held there for six hours, following which the burner is removed and a piece of 6-inch pipe installed in its place to control the air cooling. Cooling is carried out at approximately 25° per hour for the first four hours and then increased to a maximum of 50° per hour until the vessel is cool enough to unhead.

Apart from cracks in seams, close examination of the walls should be carried out in order to determine if any signs of corrosion are present; in Dubbs cracking units, when sulphur corrosion is present, generally speaking, the most affected area of the plant is the upper section of the flash chamber and the lower section of the fractionator column. In some cases where sulphur corrosion is serious the top head of the flash chamber has been found to have holes in which it was possible to place the point of the finger and these are generally more pronounced around the vapour outlet nozzles. Should such heavy corrosion be present, it will be necessary to build up the corroded area and install a protecting liner to prevent further deterioration. Serious corrosion may also be found at a point opposite the inlet of the flash chamber although in most cases a weir plate is provided

to prevent wearing down of the shell by erosion, though this sometimes corrodes and allows the vessel walls to suffer. The minimum thickness of the vessel should be measured by test holes drilled through the walls at the points which, in the inspector's opinion, show the most serious corrosion; $\frac{5}{16}$ or $\frac{3}{8}$-inch holes are quite satisfactory as long as they are large enough for the thickness gauge to pass. Test holes should be drilled in each segment of each vessel unless the condition of the vessel indicates little or no corrosion. Before taking the actual measurement it is important to be sure that all insulation has been cleared away from the area round the test hole on the outside of the vessel, otherwise inaccurate measurements will be obtained.

After the thickness has been taken the test hole should be tapped right through the wall and a plug slightly longer than the thickness of the wall screwed in and welded on the inside and outside of the shell; this is very important because if the welding on the outside is overlooked a leak may possibly develop on the inside and leak through to the insulation on the outside of the vessel.

It is advisable to examine the welded seams from the outside at least every two years and this may be rather difficult in the case of vessels which have steel housing outside and insulation as it will mean complete removal of all sections. Probably the best method is to look at one or two seams at every bi-annual inspection as this will obviate the necessity for removing all sections of housing at once. Where insulation is attached to the steel housing or is of the blanket type the better method is to weld angles to the vessels on either side of the welded seams and fill the space with insulation; when it is desired to examine the walls all that is necessary is remove these sections of insulation without disturbing that covering the balance of the vessel.

Corrosion can also be measured in vessels by means of bench marks of 18/8 chrome nickel; these are screwed plugs which are fitted into the inside wall of the vessel, the hexagon head being sawn off flush with the inside surface of the wall; as the 18/8 material will not corrode to any large extent, the distance measured from the surface of the wall to the face of the plug or bench mark will indicate the extent of corrosion.

All nozzles should be opened up, cleaned for inspection, and calipered. As a general rule nozzles are provided with alloy liners to protect them from corrosion and erosion, these liners sometimes crack or bulge and so should be carefully inspected. In some cases corrosion cuts away the wall of the vessel behind the liner at the point where the nozzle joins the shell; this may be serious as it may lead to weakening of the welded joint, and as already stated these nozzles in many cases have considerable stresses to withstand.

It has been found by experience that small nipples immediately adjoining or attached to vessels or other equipment operating at high temperatures are sometimes subject to embrittlement after some time, and in some cases they will be found to fracture when given a light tap with a hammer; for this reason, it is a good plan to renew yearly or at most every 18 months all liquid level and instrument connexions on hot lines on vessels. Corrosion is often found in receivers or separators from which water is drained off at regular intervals and this can be avoided if a leg is attached to the bottom of the vessel and the water level so controlled either by automatic or hand valve that it is not permitted to rise above the top of the leg. Where damage has already been done to the bottom head of the vessel, protection can be effected by installing a plate liner made up from used tank plate or other salvage material. It is better, however, to fit a drain leg in the

first place and avoid the possibility of corrosion. Corrosion is often noticed around liquid level connexions for a radius of about 6 inches around the nozzle. If a straight-edge is held against the vessel wall it will appear concave; if corrosion is severe, the area should be built up by welding.

Vessels are supported in different ways depending upon the service for which they are required. The majority are supported on lugs welded to the vessel walls and in some cases these lugs have been found to provide insufficient support in that they do not extend far enough over the reinforced concrete support and the weight of the vessel is therefore carried on the inside portion of the support. Where the expansion or contraction is not rapid, this is not serious, but in coke chambers which are cooled and heated very rapidly, the support has sometimes been found to tear away, particularly if the plates on which the lugs sit are not dead true. The author experienced this difficulty in Italy and Czechoslovakia and in both cases it was necessary to fit additional lugs having larger bearing surfaces; luckily in both instances there were large engineering concerns in the neighbourhood and no difficulty was experienced in fitting the supports which were fabricated from plate and welded on site.

In some cases, mostly in the older type of plant, vessels are supported on rings consisting of a number of segments, these being retained in position by high tensile stud bolts; inspection of equipment should include the periodical examination of these stud bolts, and this can best be done by replacing one at a time and taking tensile tests and measurements on one of those removed. It may not be possible in the time available, to examine all stud bolts in the supporting ring, but provided all are covered during the year, no failures are likely to be experienced. On one occasion when the stud bolts did give way, the vessel was luckily held in position by the attached piping work and no damage resulted; all the same, this kind of thing reflects no credit on the inspector.

[To be continued]

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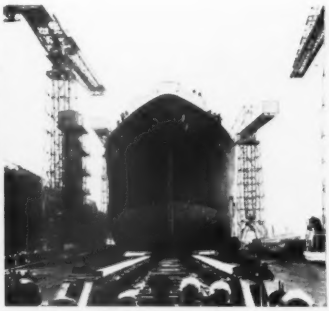

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FORTHCOMING MEETINGS

THE INSTITUTE

Production and Utilization of Petroleum Raw Materials in the U.K. Chemical Industry. Joint Meeting with London Section, Society of Chemical Industry. At Institution of Electrical Engineers, Savoy Place, London, W.C.2. 10 a.m. to 5.30 p.m., 2 March.

The International Labour Office and the Petroleum Industry. T. T. Scott (*Shell Petroleum Co. Ltd.*). At 26 Portland Place, London, W.1, 5.30 p.m. (*tea* 5 *p.m.*), 11 March.

A Symposium on the Examination of Used Lubricating Oils. At 26 Portland Place, London, W.1, 5.30 p.m. (*tea* 5 *p.m.*), 24 March.

Fawley Branch

Tanker Construction. James Melville, M.I.N.A. At Esso Recreation Club, Holbury, 7.30 p.m., 20 February.

Plastics. Harry Barron, B.Sc., Ph.D., F.R.I.C. At Esso Recreation Club, Holbury, 7.30 p.m., 20 March.

London Branch

Petroleum Chemicals in Great Britain. R. F. Goldstein, B.Sc., Ph.D., F.R.I.C. At 26 Portland Place, London, W.1, 6 p.m. (*tea* 5.30 *p.m.*), 23 February.

Address by the President. At 26 Portland Place, London, W.1, 6 p.m., 25 March.

Northern Branch

Annual General Meeting and Brains Trust. At Engineers' Club, Albert Square, Manchester, 17 February.

Lubrication—Chemist or Engineer. E. A. Evans, M.I.Mech.E., F.R.I.C. At Engineers' Club, Albert Square, Manchester, 6.30 p.m., 17 March.

South Wales Branch

The Pattern of Llandarcy. W. C. Greaves. At Training Centre Cinema, National Oil Refineries Ltd., Llandarcy, 5.30 p.m., 5 March.

Stanlow Branch

Methane at Point of Ayr Colliery. S. J. Young. Joint Meeting with Institute of Fuel. At Grosvenor Hotel, Chester, 7.30 p.m., 18 February.

Scientific Films. At Tatler Theatre, Chester, 2.30 p.m., Sunday, 1 March.

Some Chemical Applications of Mass Spectrometry. C. A. McDowell, M.Sc., A.R.I.C. Joint Meeting with R.I.C. at Grosvenor Hotel, Chester, 7.30 p.m., 5 March.

OTHER SOCIETIES

Practical Aspects of Modern Trends in Coating Protection of Buried and Submerged Structures. H. Footner and K. A. Spencer. Society of Chemical Industry. (Joint Meeting with Chemical Engineering, Newcastle Section and Corrosion Groups.) At Stephenson Building of Durham University, Newcastle, 18 February.

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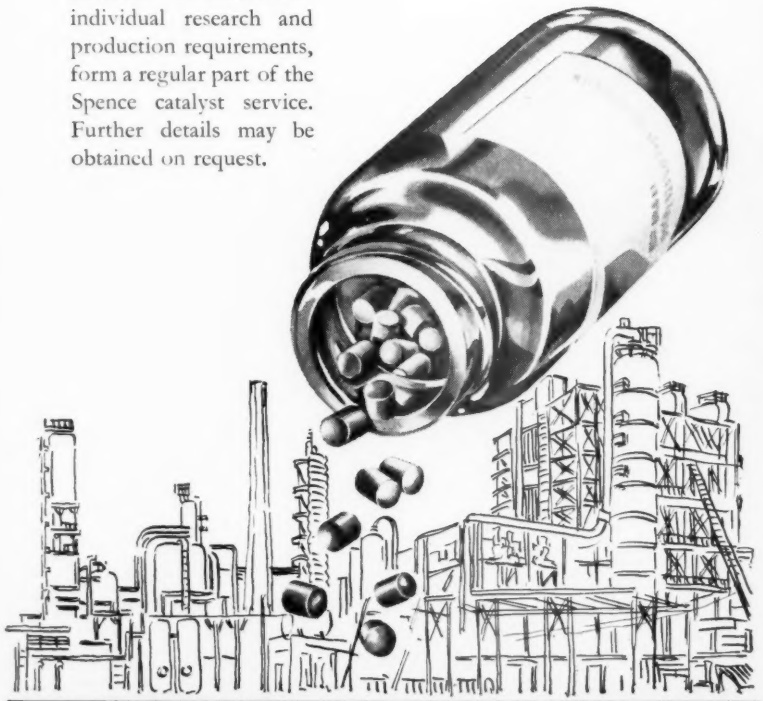

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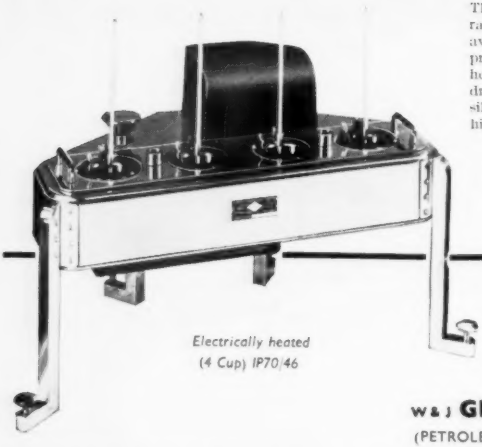

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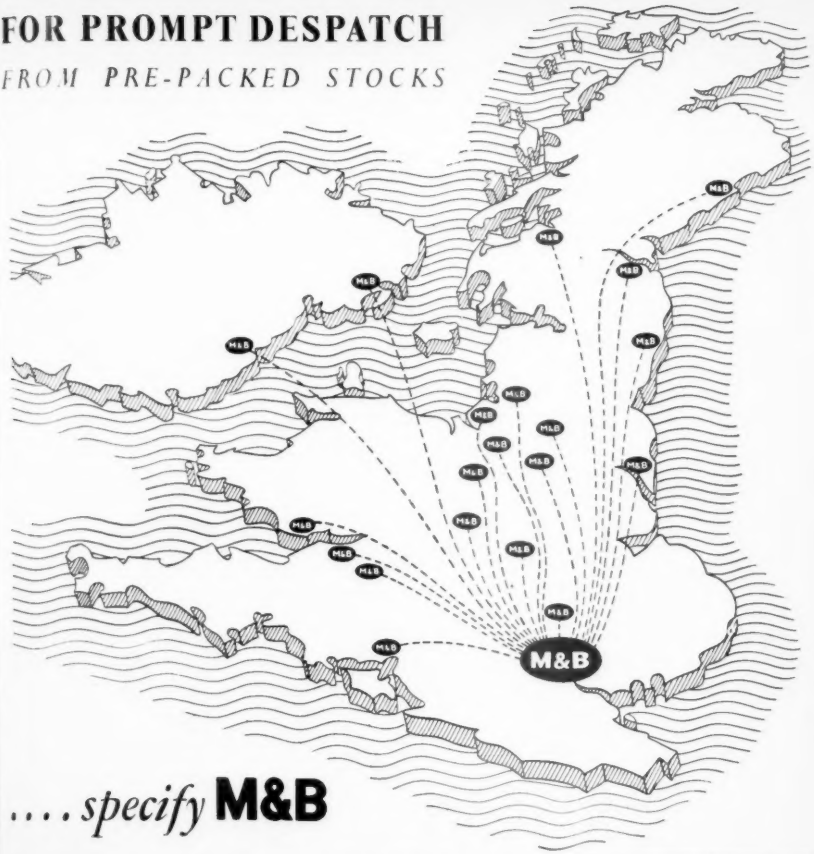

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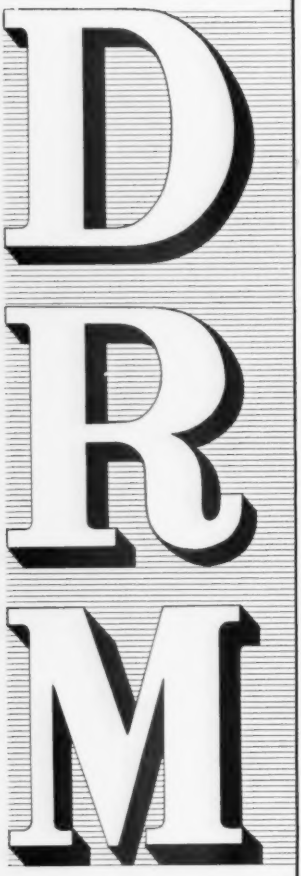

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